DISTRIBUTION AND FLORAL PREFERENCES OF THE RARE BUMBLEBEES *BOMBUS HUMILIS* AND *B. SOROEENSIS* (HYMENOPTERA: APIDAE) ON SALISBURY PLAIN

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Abstract. Studies carried out on Salisbury Plain during July–August 2002, showed that 13 *Bombus* species were present, including the nationally rare *B. humilis* Illiger and *B. soroeensis* (Fabr.). Foraging studies indicated the importance of Fabaceae as the preferred pollen source for bumblebees.

INTRODUCTION

Many bumblebee (*Bombus*) species have declined dramatically in recent decades, both in the UK, in continental Europe and in North America (Peters, 1972; Williams 1982, 1986; Rasmont, 1995; Kosior, 1995; Buchmann & Nabhan, 1996; Westrich, 1996; Westrich *et al.*, 1998). Of the 19 'true' bumblebee species and six cuckoo bumblebees known from the UK, three species are now extinct and several more are now confined to a handful of sites. Most researchers are convinced that declines in numbers of bumblebees are linked to the intensification of farming practices (Williams, 1986; Osborne & Corbet, 1994). In Europe this process has been underway for 250 years, but accelerated during the latter half of the 20th century.

The plight of our bumblebee fauna deserves particular attention because loss of bee species will have knock-on effects for other wildlife. A large number of wild plants are pollinated predominantly or exclusively by bumblebees, sometimes by particular species of bumblebee (Corbet *et al.*, 1991; Osborne *et al.*, 1991). It seems probable that reductions in the abundance and species richness of bumblebees may lead to widespread changes in plant communities (Corbet *et al.*, 1991). And of course these changes will have further knock-on effects for associated herbivores and other animals dependent on plant resources.

For practical reasons, most studies of bumblebee ecology and behaviour focus on species that are still common. In Europe, the vast majority of research covers just six species, *B. terrestris* (L.), *B. lucorum* (L.), *B. lapidarius* (L.), *B. pratorum* (L.), *B. pascuorum* (Scopoli) and *B. hortorum* (L.). For most of the approximately 40 remaining European bumblebee species, very little information on foraging preferences, or indeed on any other aspect of their ecology is available. Ecological studies of rare and declining species are urgently needed if appropriate conservation measures are to be deployed.

Salisbury Plain Training Area is the largest area of unimproved chalk grassland that remains in north-west Europe. Its status as a military training area since 1897 has protected it from most of the farming changes that have occurred elsewhere, and much of its 38,000 ha consists of lightly grazed flower-rich grassland and scrub. No attempt has been made to systematically survey Salisbury Plain for bumblebees (or indeed other invertebrates), although some localities have been well studied. Those sites that have been examined suggest

that the plain supports a diverse bumblebee assemblage, with at least 16 species present, perhaps the most that occur at any UK site (Edwards 1999; Carvell 2002). Because of the diversity of bumblebees, it is a superb site on which to study the ecology of our rarer species.

Methods

Studies were carried out between 19 July and 13 August 2002. This is late for some bumblebee species, but facilitated access since all live firing ceases on Salisbury Plain Training Area for two weeks in early August. Thirty-five sites were selected to cover the extent of Salisbury Plain Training Area, with each site at least 1.5 km from any other. Each site consisted of a circle of approximately 100 m radius, and was searched for one hour. All searches were conducted between 9:00 and 17:00 BST, and during warm dry weather favourable to bee activity. All *Bombus* species were recorded. Since our primary focus was the rare species, no attempt was made to distinguish workers of *B. terrestris* and *B. lucorum* (to do so would have been very time-consuming and unreliable in the field). *Bombus humilis* Illiger and *B. muscorum* (L.) are indistinguishable on the wing, so all specimens of these species were captured and examined with a hand lens. The area was searched systemically, to avoid recording the same bees more than once, but this probably occurred occasionally. Most bees were visiting flowers: the flower species was recorded, and each bee was observed to determine whether it was collecting pollen or nectar or both (it must be noted that this method is not as accurate as pollen load analysis for determining the relative amounts of pollen gathered from different plant species).

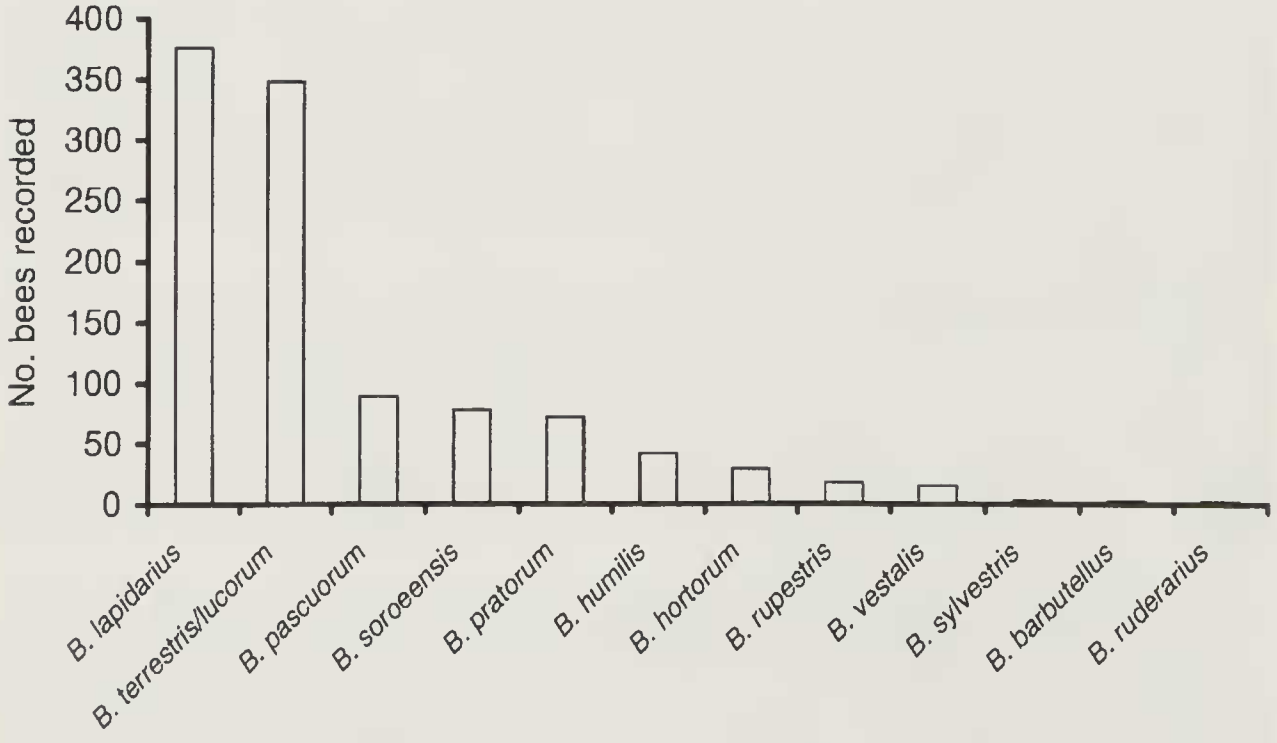


Fig. 1. Abundance of *Bombus* species recorded on Salisbury Plain (all sites combined). Observations were made between 19 July and 13 August 2002.

Results

Distribution of bumblebees

In total, 13 *Bombus* species were recorded of the 22 species currently known from the UK. By far the most common bumblebee species was *B. lapidarius*, followed by the combined category of *B. terrestris/lucorum* (Fig. 1). *Bombus lapidarius* was recorded at every site, while *B. terrestris/lucorum* were found at 33 of the 35 sites. *Bombus pascuorum* was also widely distributed, being recorded at 26 sites, but was far less abundant. *Bombus pratorum* was found at 11 sites, generally in low numbers, but at two sites dominated by scrub it was the most common species. *Bombus hortorum* was widely distributed, being found at 17 sites scattered across the plain, but always in low numbers. More interestingly, two rare species, *B. soroeensis* (Fabr.) and *B. humilis*, were found to be moderately abundant and widely distributed on the plain. Indeed, at five sites *B. soroeensis* was the most common bee recorded. The distribution of *B. soroeensis* was largely confined to the southern central part of the plain, although still spanning an area that we would conservatively estimate to cover 30–40 km^2 (Fig. 2a). One nest was discovered (3 km due west of Shrewton), the entrance to which was within a dense tussock of grass on the east-facing flank of a valley.

In comparison with *B. soroeensis*, *B. humilis* was more widely distributed, but was rarely as abundant (Fig. 2b). As with *B soroeensis*, *B. humilis* was most frequently recorded in the central part of the plain around the edges of Larkhill Impact Area. The rarest 'true' bumblebee was *B. ruderarius* (Müller), of which only two males were captured, both in the southern-central part of the plain.

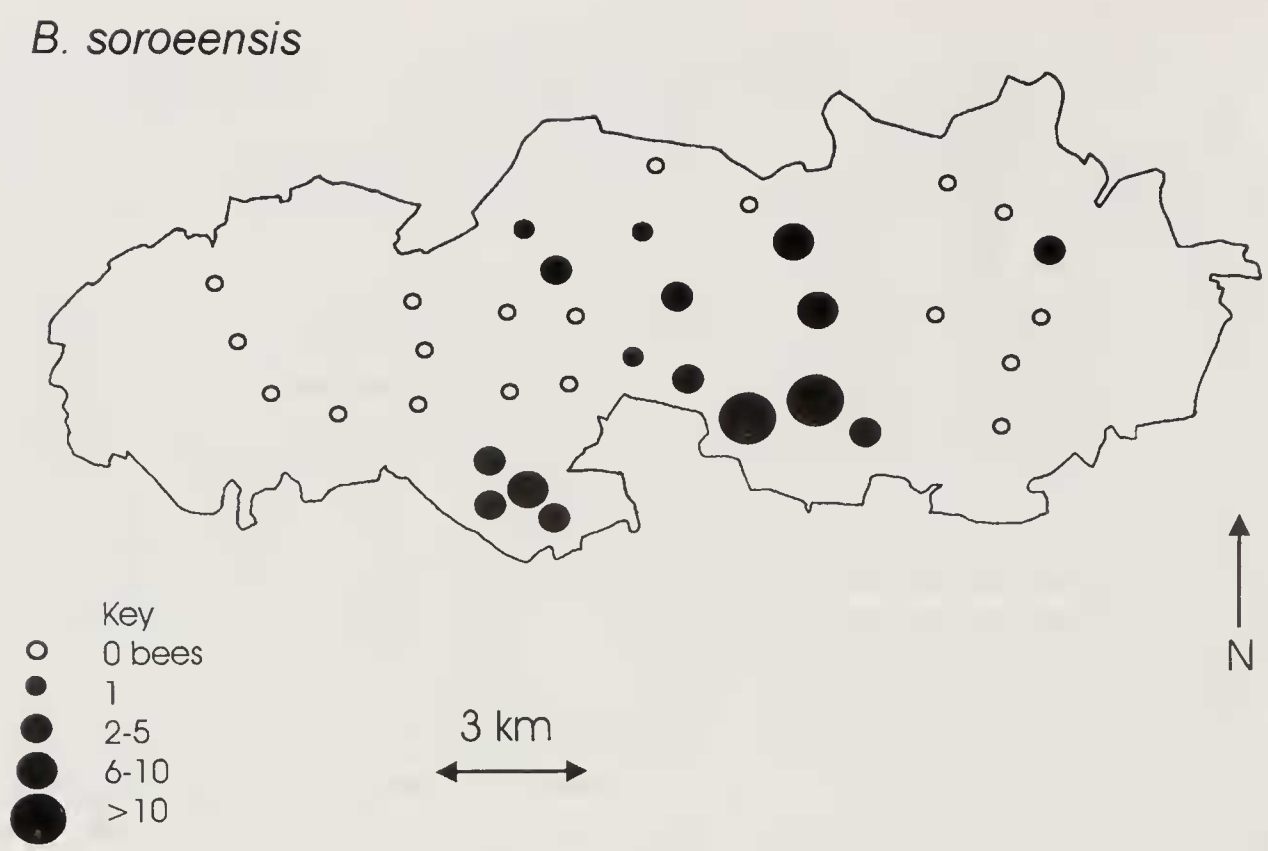
Four cuckoo bees (subgenus *Psithyrus*) were recorded (all males except for one female *B. rupestris* (Fab.)). Both *B. vestalis* (Geoffroy in Fourcroy) and *B. rupestris* were widely distributed but uncommon. Three singletons of *B. sylvestris* Lepeletier were recorded from widely separated sites, while two singletons of *B. barbutellus* (Kirby) were recorded from the southern edge of the plain.

Forage use

In total, 1,061 bumblebees were recorded visiting flowers of 33 different species. For all of the recorded bumblebee species combined, 76.0% of pollen-collecting visits were to members of the Fabaceae: notably *Onobrychis viciifolia* Scop., *Melilotus altissimus* Thuill. and *Trifolium pratense* L. The only other substantial pollen source was *Odontites vernus* (Bell.) Dum. (Scrophulariaceae), which received 11.0% of visits (Fig. 3). In contrast, nectar collection occurred across a broader range of species, mostly within the Fabaceae and Asteraceae. Notable favourites were *Centaurea scabiosa* L., *Centaurea nigra* L. (Asteraceae) and *T. pratense*.

The most specialized bumblebee in terms of its foraging preferences appeared to be *B. hortorum*, which visited *T. pratense* almost exclusively. *Bombus pratorum* also appeared to collect pollen from just two sources, *M. altissimus* and *O. vernus*. In contrast, when collecting nectar it was extremely polylectic, and appeared to opportunistically visit almost any species that was in flower.

Bombus humilis appeared to specialize in gathering both nectar and pollen from the Fabaceae (25/27 visits), but visited several species within this family, notably *T. pratense*, *Lotus corniculatus* L. and *O. viciifolia* (Fig. 4a). *Bombus soroeensis* favoured collecting pollen from *O. vernus* and various Fabaceae, notably *O. viciifolia* and *M. altissimus*. When collecting nectar this species showed very little specificity, visiting a range of Fabaceae and Asteraceae, notably *Centaurea* spp., *Cirsium* spp. and *Knautia arvensis* (L.) Coult. (Fig. 4b).



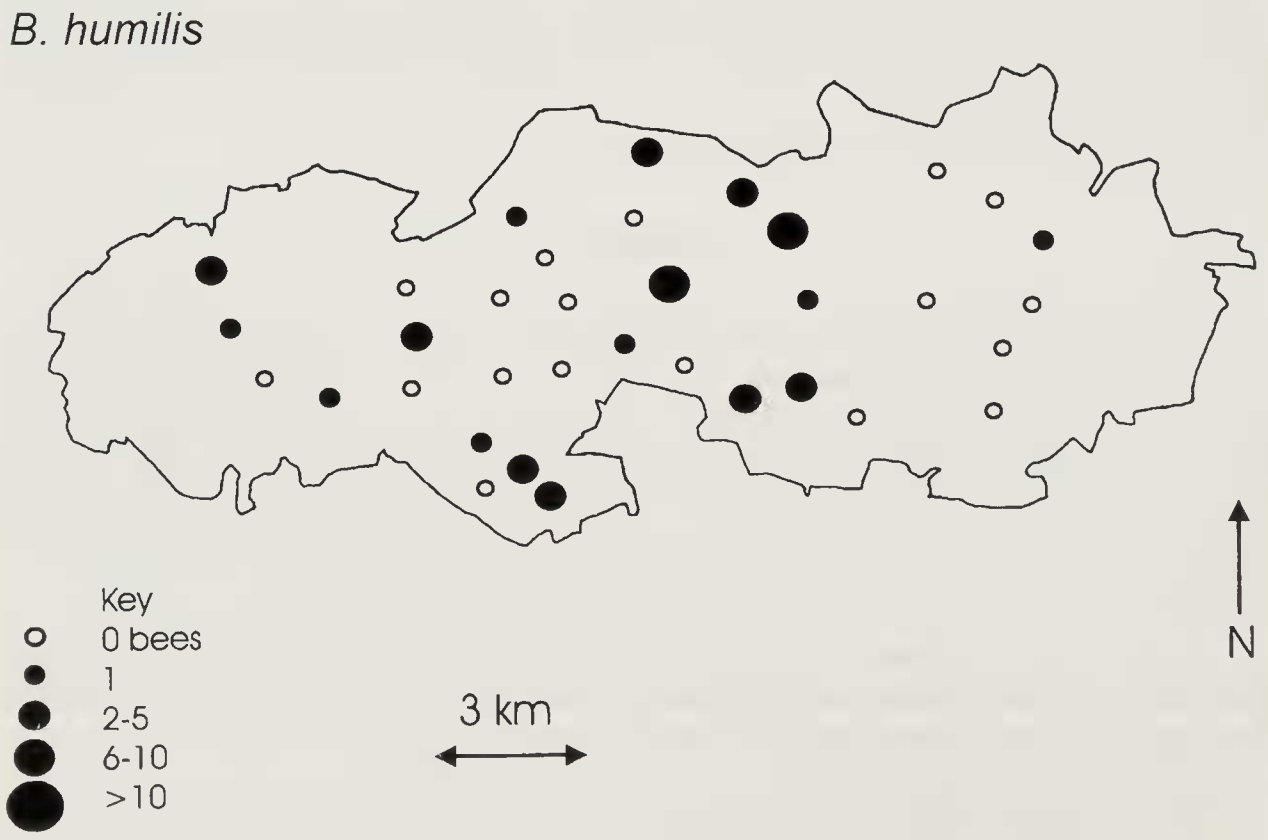


Fig. 2. Distributions of bumblebees on Salisbury Plain Training Area. Each of the 35 sites was searched for one hour, and the total number of each species recorded. a) *Bombus soroeensis*; b) *B. humilis*.

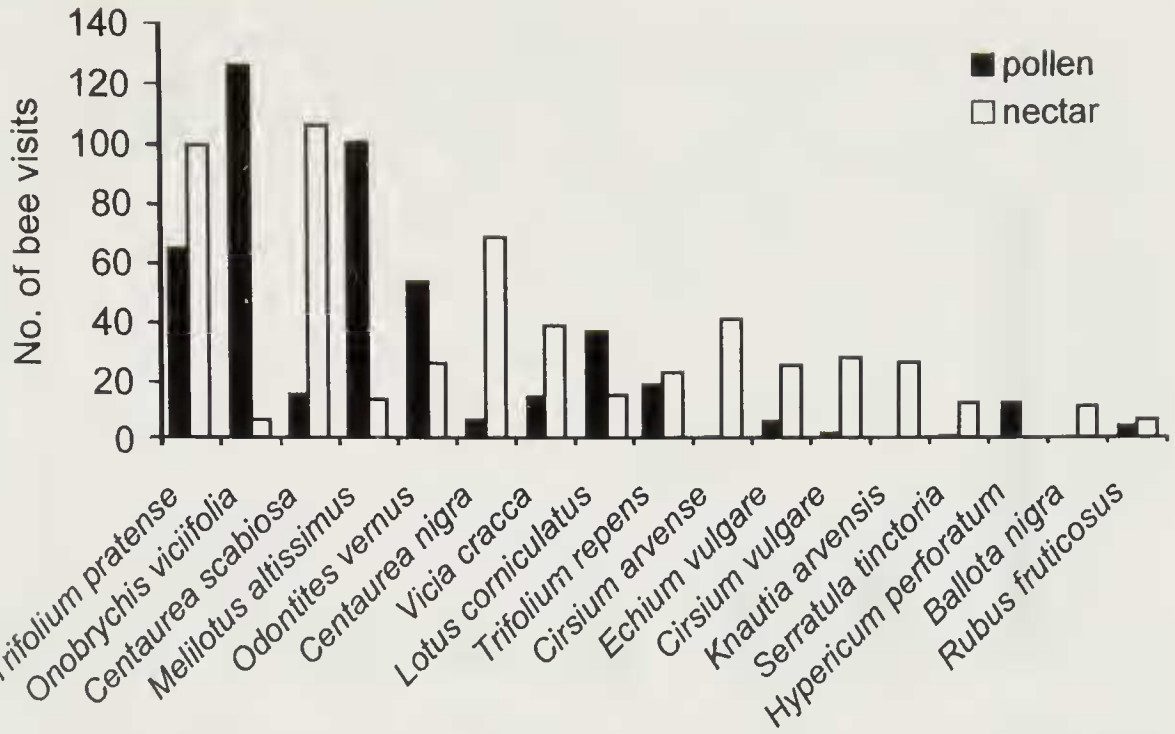


Fig. 3. Numbers of visits recorded to different flowers, according to whether pollen or nectar was collected (for all bumblebee species combined). Only plants for which at least ten visits in total were recorded are included.

The only other uncommon species observed in sufficient numbers to draw any conclusions about their foraging preferences were males of *B. rupestris*. These were most frequently observed on *Centaurea* spp. or *Cirsium* spp., favoured nectar sources of most male bumblebees. Two individuals were also seen feeding on *T. pratense*.

It must be noted that patterns of pollen and nectar collection vary between plant species according to the time of day at which nectar or pollen is released; to obtain a more accurate picture of forage use each site would ideally be observed for an entire day.

Discussion

Our data confirm the importance of Salisbury Plain Training Area as supporting a diverse bumblebee fauna, with substantial populations of rare species such as *B. humilis* and *B. soroeensis*. Both species were found over large areas, and barring major habitat changes their long-term survival on Salisbury Plain seems assured. Some species known to occur on the plain were not recorded (notably *B. sylvarum* (L.) and *B. muscorum*), but our study was short in duration and many sites were not examined. Salisbury Plain covers a vast area and many parts remain to be adequately surveyed for invertebrates. Also the lateness of our study may have meant that the flight season of some species was nearly finished: in particular, only two worn males of *B. ruderarius* were recorded, suggesting that we were too late for this species. Further studies are required earlier in the year to establish the distribution and abundance of earlier species such as *B. ruderarius*, *B. pratorum* and *B. jonellus* (Kirby).

Our results suggest that at least some of the bumblebees on Salisbury Plain Training Area are largely reliant on a rather small number of plant species. Despite the floristic diversity on Salisbury plain, 65% of all flower visits by bumblebees were to just six plant species (of course, earlier in the year other plant species will be used). In particular, pollen was collected overwhelmingly from Fabaceae (76% of visits). Some species, notably *B. humilis*, gathered pollen almost exclusively from Fabaceae, while

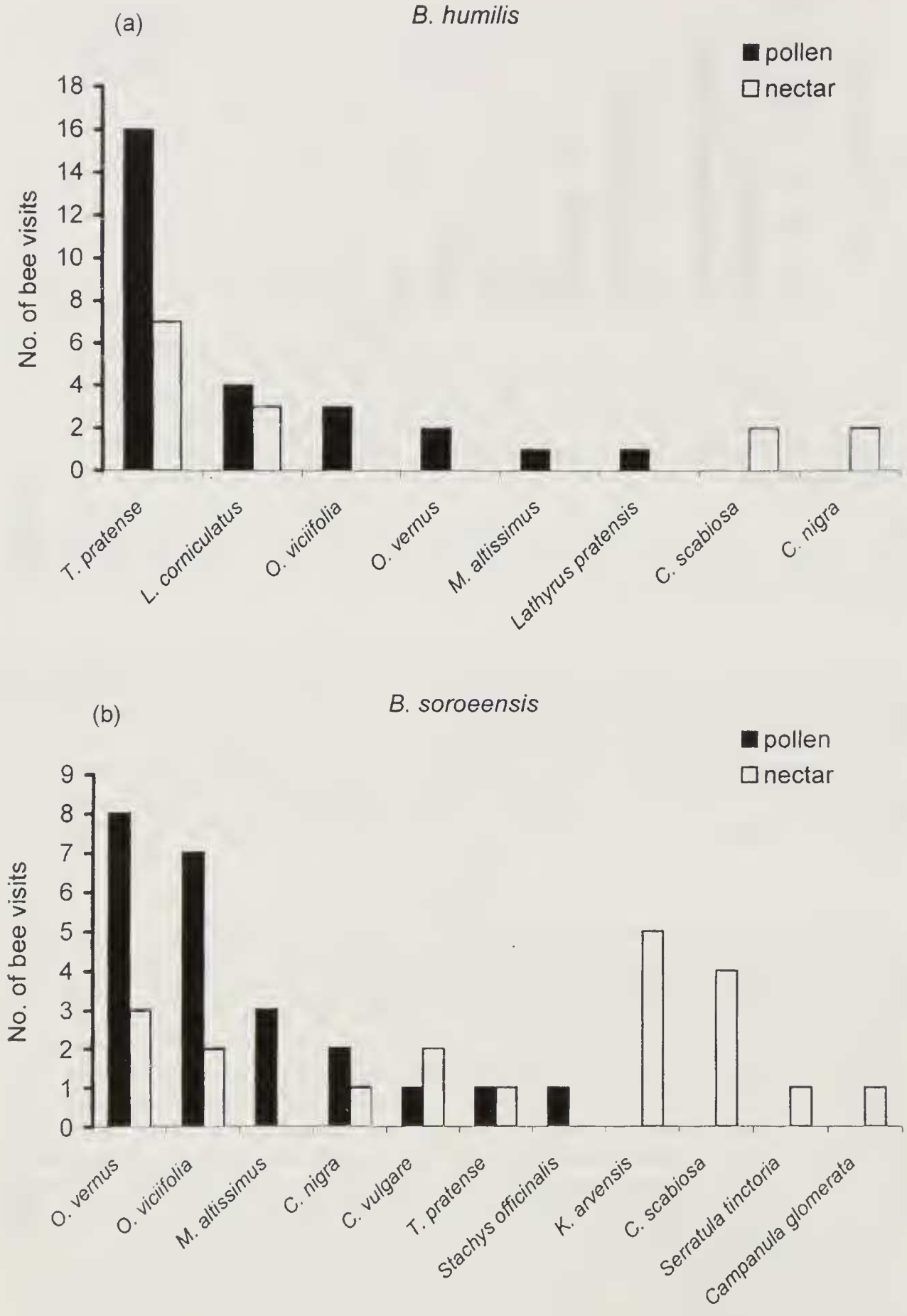


Fig. 4. Numbers of visits recorded to different flowers, according to whether pollen or nectar was collected. All bees were workers, apart from one male of each species recorded visiting *Centaurea nigra*. a) *Bombus humilis*; b) *B. soroeensis*.

B. hortorum was even more specific, gathering pollen largely from just one species, *T. pratense*. Brian (1951) found that pollen from red clover made up 74% of larval food in *B. hortorum* nests in Scotland, and studies in Finland, Sweden and Denmark all suggest the importance of red clover for this and other longer-tongued bumblebee species (Skovgaard, 1936; Teräs, 1985; Jennersten *et al.*, 1988, Rasmont, 1988). Most recently, Carvell (2002) found a strong correlation between abundance of *T. pratense* and abundance of both *B. hortorum* and *B. humilis* on Salisbury Plain Training Area.

It is not known why Fabaceae are the preferred pollen source for bumblebees in general, nor why some bumblebees are more specific in their pollen requirements than others. Fabaceae may simply produce more pollen than members of other plant families, although this seems unlikely and is not apparent from casual inspection of the flowers. Alternatively, there are presumably qualitative differences in pollen from different plant families; perhaps, for example, pollen from Fabaceae contains a higher proportion of protein. Since pollen is the only source of protein for developing brood, its quality is likely to be crucial.

Bombus soroeensis is a species about which very little is known, and in recent years it has been recorded from rather few sites in the UK (although there may be a degree of under-recording; it superficially resembles *B. terrestris*). It is a short-tongued species, and in terms of its foraging preferences, it appears to be quite generalized. It is probably fair to say that we have no idea why it has a restricted distribution, when other species such as *B. terrestris*, which are also short-tongued and have generalized foraging preferences, are very common. The healthy population on Salisbury Plain provides an excellent opportunity to study this species further.

Acknowledgements

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References

Brian, A. D., 1951. The pollen collected by bumble-bees. *Journal of Animal Ecology* **20**: 191–194.

Buchmann, S. L. & Nabhan, G. P., 1996. *The Forgotten Pollinators*. Washington (DC): Island Press.

Carvell, C., 2002. Habitat use and conservation of bumblebees (*Bombus* spp.) under different grassland management regimes. *Biological Conservation* **103**: 33–49.

Corbet, S. A., Williams, I. H. & Osborne, J. L., 1991. Bees and the pollination of crops and wild flowers in the European Community. *Bee World* **72**: 47–59.

Edwards, M., 1999. U.K. Biodiversity Action Plan Bumblebee Working Group Report 1999. Unpublished report for the UK BAP bumblebee working group, Midhurst, UK.

Jennersten, O., Berg, L. & Lehman, C., 1988. Phenological differences in pollinator visitation, pollen deposition and seed set in the sticky catchfly *Viscaria vulgaris*. *Journal of Ecology* **76**: 1111–1132.

Kosior, A., 1995. Changes in the fauna of bumble-bees (*Bombus* Latr.) and cuckoo-bees (*Psithyrus* Lep.) of selected regions in southern Poland, pp. 103–111. In: Banaszak, J., (Ed.), *Changes in Fauna of Wild Bees in Europe*. Pedagogical University.

Osborne, J. L. & Corbet, S. A., 1994. Managing habitats for pollinators in farmland. *Aspects of Applied Biology* **40**: 207–215.

Osborne J. L., Williams I. H. & Corbet, S. A., 1991. Bees, pollination and habitat change in the European community. *Bee World* **72**: 99–116.

Peters, G., 1972. Ursachen fur den Rückgang der seltenen heimischen Hummelarten (Hym., *Bombus* et *Psithyrus*). *Entomologische Berichten* **1972**: 85–90.

Rasmont, P. 1988. Monographie écologique et zoogeographique des Bourdons de France et de Belgique (Hymenoptera, Apidae, Bombinae). Gembloux, Belgium, Faculté des Sciences Agronomique de l'Etat.

Rasmont, P., 1995. How to restore the apoid diversity in Belgium and France? Wrong and right ways, or the end of protection paradigm!, pp. 53–64. In: Banaszak, J., (Ed.), *Changes in Fauna of Wild Bees in Europe*. Pedagogical University.

Skovgaard, O. S., 1936. Rødkloverens Bestøvning. Humlebier og Humleboer. Det Kongelige Danske Videnskabernes Selskabs Skrifter Naturvidenskabelig og Mathematisk Afdeling. 9. *Raekke* **6**: 1–140.

Teräs I., 1985. Food plants and flower visits of bumble-bees (*Bombus*: Hymenoptera, Apidae) in southern Finland. *Acta Zoologica Fennica* **179**: 1–120.

Westrich, P., 1996. Habitat requirements of central European bees and the problems of partial habitats, pp. 2–16. In: Matheson, A., Buchmann, S. L., O'Toole, C., Westrich, P., Williams, I. H. (Eds.) *The conservation of bees*. London: Academic Press.

Westrich, P., Schwenninger, H.-R., Dathe, H., Riemann, H., Saure, C., Voith, J. & Weber, K., 1998. Rote Liste der Bienen (Hymenoptera: Apidae), pp. 119–129. In: Bundesamt für Naturschutz. (Ed.) *Rote Liste Gefährdeter Tiere Deutschlands*. Naturschutz 55, Bonn: Schriftenr. Landschaftspf.

Williams, P. H., 1982. The distribution and decline of British bumble bees (*Bombus* Latr). *Journal of Apicultural Research* **21**: 236–245

Williams, P. H., 1986. Environmental change and the distribution of British bumble bees (*Bombus* Latr.). *Bee World* **67**: 50–61.

SHORT COMMUNICATION

***Gonocerus acuteangulatus* (Goeze) (Hemiptera: Coreidae) new to Kent.**—On 15 April 2003, I knocked a specimen of *Gonocerus acuteangulatus* from a Lawson's cypress tree in Horniman Gardens, Surrey, TQ349732. It landed, briefly, in a spider's web, from which I took it into my hand. The day was warm and sunny and the bug was very active. After a few seconds it flew off across the grass, over a fence and disappeared into the adjoining gardens of Forest Hill. Although once restricted to the box trees of Box Hill, this bug has spread dramatically throughout Surrey during the last 10 years, expanding its choice of foodplants to include hawthorn and yew (R. Hawkins, personal communication). I was not too surprised, therefore, to find it on the cypress. This alien garden tree has become host to several heteropteran bug species of late, including the lygaeid ground bug, *Orsillus depressus* Dallas, the juniper shieldbug, *Cyphostethus tristriatus* (Fab.), and the juniper leaf-bug, *Dichrooscytus gustavi* (Jos.) (Jones, R. A., 2000. *Entomologist's. Rec. J. Var.* **112**: 133–134). However, it is more likely that *Gonocerus* was overwintering on the cypress, rather than feeding on it. The vice-county boundary between Surrey (VC17) and West Kent (VC16) runs right through Horniman Gardens, following the ridge of the hill. So I felt a certain thrill as I watched *Gonocerus* fly away, because I realized that its flight took it out of Surrey and a few metres into Kent . . . a new record for the county? In fact, I later discovered that this was not the first time that the bug had been found in Kent. Roger Hawkins tells me that, on 6 September 2002, he was recording shieldbugs for the forthcoming Surrey Wildlife Trust atlas right on the very edge of the county, but had to walk there from the railway station at Edenbridge in Kent. The bushes of hawthorn and rose beside the station looked like a suitable habitat for this bug, but it took at least half-an-hour of systematic beating before a single adult *Gonocerus* was found, on hawthorn by a field to the west of the station (TQ437475) He was 1.5 kilometres inside West Kent at the time.—RICHARD A. JONES, 135 Friern Road, East Dulwich, London SE22 0AZ (bugmanjones@hotmail.com)